SOUTH AFRICAN CIVIL AVIATION AUTHORITY

PRELIMINARY ACCIDENT REPORT

ACCIDENT REFERENCE: **CA18/2/3/8894**

AIRCRAFT REGISTRATIONS: **ZS-GAA**

AIRCRAFT TYPES: **PILATUS PC-12/47**

DATE OCCURRED: **08 FEBRUARY 2011**

LOCATION: **AT SEA ON APPROACH TO PLETTENBERG BAY AERODROME.**

BACKGROUND:

The aircraft, which was operated under the provisions of Part 91 of the Civil Aviation Regulations (CARs), departed from Queenstown Aerodrome (FAQT) at 1329Z on an instrument flight plan for Plettenberg Bay Aerodrome (FAPG). On board the aircraft were two (2) crew members and seven (7) passengers. The estimated time of arrival for the aircraft to land at FAPG was 1430Z, however the aircraft never arrived at its intended destination, nor did the crew cancel their search and rescue as per flight plan/air navigation requirements. At ±1600Z an official search for the missing aircraft commenced. The search was co-ordinated by the Aeronautical Rescue Co-ordination Centre (ARCC). The first phase of the search, which was land based, was conducted in the Robberg Nature Reserve area. Progress was slow due to poor visibility associated with dense mist and night time. A sea search was not possible following activation of the official search during the late afternoon and night time, but vessels from the National Sea Rescue Institute (NSRI) were able to launch at first light the next morning. Floating debris (light weight material) was picked up from the sea and along the western shoreline of the Robberg Nature Reserve where foot patrols were conducted. On 11 February 2011 the South African Navy joined the search for the missing wreckage by utilizing side scan sonar equipment to scan the sea bed for the wreckage. All the occupants on board the aircraft were fatally injured in the accident.

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator : Majuba Aviation (Pty) Ltd

Manufacturer : Pilatus Aircraft Limited

Model : PC-12/47

Nationality : South African

Registration Marks : ZS-GAA

Place : In the sea near Plettenberg Bay

Date : 8 February 2011

Time : 1433Z

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to establish legal liability****.*

Disclaimer:

This report is produced without prejudice to the rights of the CAA, which are reserved.

1. FACTUAL INFORMATION

1.1 History of Flight:

1.1.1 On 7 February 2011, the aircraft ZS-GAA was refuelled to capacity at Lanseria Aerodrome (FALA) in preparation for the flight the next day and 1 215 litres of Jet A1 fuel was uplifted. The flight, which was conducted under the provisions of Part 91 of the Civil Aviation Regulations (CARs) departed from FALA at 0403Z on 8 February 2011 for Newcastle, where the delegation (passengers) attended a meeting. On board the aircraft were two (2) crew members and seven (7) passengers. From Newcastle Aerodrome (FANC) they flew to Queenstown Aerodrome (FAQT) where they also attended a meeting. At 1329Z the aircraft departed from Queenstown Aerodrome for Plettenberg Bay Aerodrome (FAPG) on an Instrument Flight (IF) plan with an estimated time of arrival for FAPG to be 1430Z. According to secondary surveillance radar (SSR) footage, the aircraft

disappeared from radar at approximately 1433.31Z. The Google Earth map below displays the route that was flown by the aircraft on 8 February 2011. The blue block values reflect the estimated fuel consumption for each leg flown, based on data that was obtained from the aircraft flight folio, which was recovered from the sea (the average fuel consumption used for these calculations was 400 pounds per hour).

This Google Earth map displays each leg of the flight and associated fuel consumption.

1.1.2 According to a person who went to the Plettenberg Bay aerodrome to collect some of the passengers who were on the aircraft ZS-GAA, he arrived at the aerodrome at approximately 1428Z. At the time it was overcast and drizzling. He met up with another person at the aerodrome who had also come to collect one of the passengers. That person was waiting in his vehicle to escape the rain. They had a short conversation through the car window and he made the comment that the aircraft would probably not land at FAPG and would probably re-route to George instead. At approximately 1436Z he received a cell phone call from his wife who informed him that she had just received a cell phone call from one of the passengers on board the aircraft informing her that they were diverting to George, which was 47 nm towards the West of FAPG, and that they should arrange transport for them from George to Plettenberg Bay. In a statement received from the person who received the cell phone call, she indicated that the duration of the call was approximately 37 seconds and it was received on her phone at 1431Z (the

person further stated that the time on her cell phone might not have been accurate and could have been slightly behind by a minute or two) and that the actual time when she received the call could have been around 1433Z. The cell phone service provider was contacted in order to obtain the actual time of the call. According to them the call was made at 1432:52Z (16h32 and 52 seconds - local time) and the duration of the call was 38 seconds.

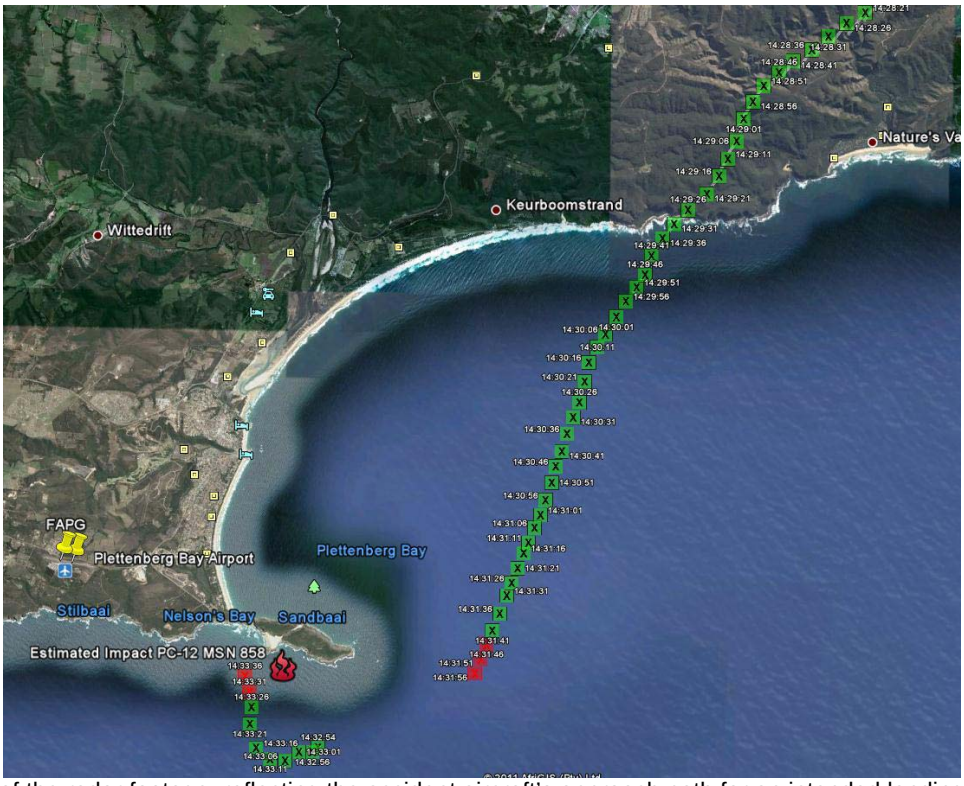
1.1.3 The person who had received the call relayed the message to the person who was waiting in his vehicle outside the terminal building, whereupon he drove from the aerodrome to his office in town where he arranged for a mini-bus from a vehicle rental company, via a travel agent, for collection at George aerodrome. At approximately 1510Z he phoned one of the passengers to inform him about this arrangement, but the phone went straight to voice mail. At approximately 1515Z he phoned George Aerodrome, Air Traffic Control (ATC) to ask if the aircraft had landed at George, and if not, when they were expected to land. George ATC had no information on the flight and suggested that he phone Cape Town ATC in order to establish if they had had any communication with the aircraft and its intended routing. He was informed by Cape Town that the aircraft had landed at FAPG, upon which he informed them that it hadn't. A few minutes later Cape Town ATC phoned him back, requesting more information.

1.1.4 During radio contact with Cape Town Area East at 14:27.03Z the crew of ZS-GAA had indicated to ATC that they would cancel search and rescue once on the ground. According to available information the last communication between the aircraft and Cape Town Area East was at 1433.03Z, at which period search and rescue was still active. Following the last communication with the aircraft, Cape Town Area East tried to establish radio contact with the aircraft several times thereafter but all efforts were in vain and an Incerfa (uncertainty phase) was declared, which was upgraded a short while later directly to a Detresfa (distress phase).

1.1.5 An official search and rescue operation was activated by the Aeronautical Rescue Coordination Centre (ARCC) in Johannesburg at ±1600Z in order to start searching for the missing aircraft. The last known position of the aircraft according to secondary surveillance radar (SSR) was used as a basis for the search. Two South African Air Force (SAAF) aircraft were placed on standby to participate in the search. One would have conducted the sea search and the second the land search. Due to inclement weather conditions in the Plettenberg Bay area at the time it was not possible to dispatch either of the aircraft to start with the search, nor was it

possible to dispatch any boats to start with an official sea search as visibility was described as ‘poor in dense fog’. Several pieces of floating debris were located towards the western side of the Robberg Nature Reserve and were being picked up from the sea by search vessels of the National Sea Rescue Institute (NSRI) that were able to dispatch at first light the next morning. Several pieces of debris (light weight material) were also located along the shoreline on the western side of the Robberg Nature Reserve by people doing foot patrols in the area. These foot patrols continued for several days after the accident had occurred, with only minor pieces of debris (light weight material) being picked up on the western side of the Robberg Nature Reserve.

1.1.6 Radar footage was obtained for the accident aircraft (ZS-GAA) as well as a Cessna Citation that had landed at FAPG at approximately 1210Z, ± 2½ hours prior to the expected time of arrival of the accident aircraft. It is clear from the radar track of the accident aircraft, which had approached Plettenberg Bay from the north-east, that the crew had flown a different approach to that of the Cessna Citation crew, which also approached the aerodrome from the north-east (inbound from FALA to FAPG). The Cessna Citation crew joined overhead the aerodrome and then flew the cloud-break procedure for runway 30 twice, prior to landing at FAPG. According to a statement that was obtained from both crew members of the Cessna Citation, they initiated a go-around on their first approach due to limited forward visibility, associated with low cloud and rain while on final approach for Runway 30. The accident aircraft approached Plettenberg Bay from the north-east and between Keurboomstrand and Nature’s Valley descended over the sea in a south-westerly direction for a distance of approximately 7.3 nautical miles (nm), which was followed by a right turn around the Robberg Nature Reserve point (see radar trajectory below). Prior to radar coverage being lost with the aircraft there was no indication that the crew had initiated any change in course, which could be associated with a diversion to George aerodrome (FAGG).



A clip of the radar footage, reflecting the accident aircraft's approach path for an intended landing at FAPG.

1.1.7 The aircraft crashed into the sea approximately 1 000 m off shore, on the western side of the Robberg Nature Reserve during daylight conditions on 8 February 2011. There were no eye-witnesses to the crash, which could be attributed to the inclement weather conditions that prevailed in the area at the time. Weather conditions were reported to be overcast with a cloud base of approximately 200 feet above sea level with dense fog and drizzle at the time. Several people were interviewed who stated that they saw the aircraft flying over their houses, but this information appeared to be erroneous as the aircraft never flew over land once it went over the sea between Keurboomstrand and Nature's Valley.

1.1.8 Following confirmation of the accident, a team of South African Police divers who were mainly from the Western Cape, were dispatched to Plettenberg Bay. The teams arrived in Plettenberg Bay on Wednesday, 9 February 2011, but due to rough conditions at sea were unable to commence with any diving until mid-day on Thursday, 10 February 2011.

1.1.9 On Friday afternoon, 11 February 2011 the South African Navy joined the search for the missing wreckage after an official request by the South African Civil Aviation Authority had been made to the SA Navy. The vessel that was dispatched for this purpose carried specialised equipment that could scan the seabed, utilizing a side scan sonar. The side scan sonar proved to be very effective and a substantial percentage of the aircraft's wreckage (large pieces) could be located and recovered

by analysing the data and diving in the areas specified. Navy divers who were dispatched with the vessel assisted the police divers with the recovery of the wreckage. The majority of large pieces were floating and were lifted onto the navy vessel where they were rinsed with fresh water immediately. The vessel remained on anchor in the area until Monday, 14 February 2011 at 1600Z, whereafter it sailed to the port of Port Elizabeth where all the recovered pieces of wreckage were offloaded onto a truck and were taken to a secure location the following morning.

1.1.10 The crew of the Cessna Citation that had landed at FAPG at approximately 1210Z indicated in their statements that on their approach for FAPG, which was from the north-east, overcast (8/8 of cloud) conditions prevailed along the coast, with the cloud ceiling (top of cloud) being at approximately 5 500 feet. Once over the NDB beacon, Pappa Yanky (PY) at FAPG, they followed the published cloudbreak procedure for runway 30. The crew indicated the cloud base to have been at approximately 1 400 feet as they descended on the approach with forward visibility varying between a 1 000 and 2000 metres, with scattered rain showers. During their first approach to land they initiated a go-around, as their forward visibility was substantially impaired when they encountered low cloud and rain on the final segment of the approach. According to the pilot-in-command (PIC), Robberg was clearly visible during the second approach which they flew, but visibility towards the west of the aerodrome was described as poor. According to their onboard flight director/GPS, the indicated wind at 2 000 feet above mean sea level (AMSL) was ±18 knots from the west at that stage. On their second approach they had the runway visual and proceed with an uneventful landing. According to the crew the NDB beacon at FAPG was serviceable during both the approaches and the landing.

1.1.11 The accident occurred during daylight conditions at a geographical position determined to be South 34° 06'.954 East 023° 23'.522. Most of the wreckage was located at a depth of between 28 to 35 metres below the sea. The majority of floating debris that was picked up, was located on the western shoreline of the Robberg Nature Reserve. The majority of the floating debris in the sea was picked up by crew members of the National Sea Rescue Institute (NSRI) boats, and were mostly concentrated towards the West of the Robberg Nature Reserve. All the occupants onboard the aircraft were fatally injured in the accident.

1.2 Injuries to Persons:

Injuries	Pilot	Crew	Pass.	Other
Fatal	1	1	7	-
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-

1.3 Damage to Aircraft:

1.3.1 The aircraft was destroyed during impact with the sea.

1.4 Other Damage:

1.4.1 Apart from a minor fuel spill, no other environmental damage was caused.

1.5 Personnel Information:

1.5.1 Pilot-in-command (PIC)

Nationality	South African	Gender	Female	Age	32
Licence Number	**********	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Instrument Rating, Instructor's Rating Grade 2				
Medical Expiry Date	31 March 2011				
Restrictions	None				
Previous Accidents	None				

Flying Experience:

Total Hours	2 662.3
Total Past 90 Days	34.7
Total on Type Past 90 Days	34.7
Total on Type	582.2

*NOTE:

The hours reflected in the table above were obtained from a copy of the pilot's logbook that was made available to the Accident and Incident Investigation Division (AIID). The last entry in the logbook was dated 23 December 2010. There were a few additional flights that were recorded in the aircraft flight folio, which was recovered from the sea, which indicated that the pilot had flown an additional 3.5 hours on the Pilatus PC-12 (ZS-GAA) until the time of the accident.

Brief Flying History:

According to the available information (CAA Pilot file) the pilot had flown her practical flight test to obtain her private pilot's licence on 29 June 2001. On 4 July 2001 all the required paperwork was submitted to the regulating authority and her private pilot's licence (aeroplane) was issued.

On 6 November 2003 she was subjected to a flight test (skills test) in order to obtain her commercial pilot's licence. The following day the required paperwork (application for a professional pilot's licence - commercial) was submitted to the regulating authority and her commercial pilot's licence (aeroplane) was issued. Her pilot's licence as well as her instrument rating were valid for a period of one year and were renewed annually thereafter.

On 25 April 2004 she was subjected to a practical flight test (initial) for her flight instructor's rating grade III, which she passed. The rating was endorsed on her licence on 4 May 2004, following submission of the required paperwork to the regulating authority. On 29 April 2005 she had conducted a practical flight test to upgrade her flight instructor's rating to grade II level, which was subsequently issued.

The pilot commenced with her Pilatus PC-12 type conversion training on 8 February 2008 and had submitted her "Application for Flight Crew Licence Conversion" (form CA61-13.02) to the regulating authority on 7 March 2008. Her application form reflects that she had flown a total of 14.5 hours dual flight training during her type conversion onto the Pilatus PC-12. A copy of her syllabus as well as practical flight test report on the Pilatus PC-12 was available on her CAA pilot file. She also had a Boeing 767-300 (Co-pilot restricted) as well eleven (11) smaller general aviation aircraft endorsed on her pilot's licence.

Her last practical flight test/skills test (renewal of instrument rating - aeroplane) prior to the accident flight was conducted on 29 March 2010 on a Cessna 210 type of aircraft.

According to an entry in the pilot's logbook as well as flight folio entries (page reference numbers 7202 and 7203) the last time the pilot had landed at Plettenberg Bay aerodrome was on 16 March 2010 with a Pilatus PC-12. The flight folio indicated that they departed from FAPG the next morning for a flight to Cape Town.

1.5.2 First Officer (F/O)

Nationality	South African	Gender	Female	Age	30
Licence Number	**********	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Instrument Rating, Instructor's Rating Grade 3				
Medical Expiry Date	30 June 2011				
Restrictions	Must wear suitable corrective lenses.				
Previous Accidents	None				

Flying Experience:

Total Hours	351.8
Total Past 90 Days	18.7
Total on Type Past 90 Days	6.8
Total on Type	112.6

*NOTE:

The hours reflected in the table above were obtained from a copy of the pilot's logbook (hard copy) that was made available to the Accident and Incident Investigation Division (AIID). The last entry in the logbook was dated 9 December 2010. It was noted that her last flight on a Pilatus PC-12 according to the logbook copies was on 31 October 2010. It came to the attention of the investigating team that the pilot had conducted another flight on the aircraft type on 26 December 2010 as first officer. The routing of this flight was as follows: FALA to FAJS to Buffalo Range (FVCZ) in Zimbabwe and back to FALA; with a total flight duration of 3.6 hours. The pilot's next flight(s) on the aircraft type was on 8 February 2011, which included the accident flight. Following her conversion onto type she was required to fly 50 hours as pilot-in-command under supervision (PICUS) before she could act

as PIC (believed to be an insurance requirement). It was noted that the pilot had never flown the Pilatus PC-12 as pilot-in-command. Her logbook was kept in electronic format (on a laptop), which was onboard the aircraft at the time of the accident. The laptop was not recovered from the sea.

Brief Flying History:

According to available information (CAA Pilot file and pilot's logbook) the pilot had flown her practical flight test to obtain her private pilot's licence on 23 July 2006. On 31 July 2006 all the required paperwork was submitted to the regulating authority and her private pilot's licence (aeroplane) was issued.

On 15 July 2009 she was subjected to a flight test/skills test in order to obtain her commercial pilot's licence. On the same day she also conducted her flight test (skills test) for her Instrument Rating. On 21 July 2009 the required paperwork (forms; CA61-15.06 and CA61-05.02 along with the forms CA61-05.02.1 and CA61-15.06) was submitted to the regulating authority and her commercial pilot's licence (aeroplane) as well as her instrument rating was issued. Her pilot's licence as well as her instrument rating were valid for a period of one year and were renewed annually.

On 24 July 2009 she completed her type conversion onto the Pilatus PC-12 under the auspices of an approved Aviation Training Organisation (ATO). This was her first conversion onto an HPA (High Performance Aircraft {gas turbine engine driven aircraft}). On 29 July 2009 the form CA61-13.06 (Application for Class, Warbird or Type Rating) was submitted to the regulating authority. The authority then endorsed the aircraft type rating onto her pilot's licence, which was also endorsed in her pilot logbook. According to the available information (form; CA 61-13.06) she had flown a total of 2.3 hours dual (one flight) to complete her conversion onto the aircraft type.
The ATO under which the type conversion was conducted, was consulted by the investigating team, as the team required clarity with reference to the Pilatus PC-12 type conversion.

The following information was requested from the ATO during a visit to the facility on 17 March 2011;

(i) A copy of the approved Pilatus PC-12 syllabus.
(ii) Pilatus PC-12 training/course material.

(iii) The pilot's training file, that was required to contain her written examinations (i.e., technical, performance, procedures and emergencies).

(iv) Skills/Flight Test Report.

None of the information requested could be made available for evaluation purposes, nor was it available on the pilot's file in possession of the regulating authority. The ATO was required in accordance with the Civil Aviation Regulations (CARs) to have kept all records in safety for a period of at least five (5) years, calculated from the date of the last entry made in such records; as follows:

Part 141.02.15 (Documents and records)

"(3) The holder of the approval shall establish procedures to identify, collect, index, store and maintain all records which may be necessary –
(a) for the specified aviation training conducted by such holder;
(b) to determine compliance with the appropriate requirements prescribed in this Subpart.
(4) The procedures referred to in sub-regulation (3) shall ensure that –
(a) a record is kept of each quality control review of the holder of the approval;
(b) a record is kept of each person who conducts the specified aviation training, including particulars of the competence assessments and experience of each such person;
(c) a record is kept of each student being trained or assessed by the holder of the approval, including particulars of enrolment, attendance, modules, instructor comments and any flight or similar practical sessions and assessments of each such student;
(d) all records are legible; and
(e) all records are kept for a period of at least five years calculated from the date of the last entry made in such records".

It was noted that the ATO through which the pilot received her Pilatus PC-12 conversion was in possession of a valid ATO Accreditation and Approval Certificate for Standard Aviation Training at the time. The ATO Approval certificate was issued on 8 June 2009 and expired on 30 June 2010. The certificate was issued following an audit that was conducted at the facility on 8 May 2009.

The pilot's last practical flight test prior to the accident flight was an evaluation for her flight instructor's rating. The flight was conducted on 9 December 2010 on a Cessna 172 type aircraft. Following an evaluation of the test, the flight examiner

found her proficient to act as a flight instructor grade III. This rating was endorsed in the pilot's licence on 13 December 2010, following submission of the required paperwork to the regulating authority.

1.6 Aircraft Information:

1.6.1 Description of the Aircraft.

The Pilatus PC-12 is a single-engine turboprop passenger and cargo aircraft with its primary application being corporate transport as well as emergency medical services (air ambulance). It is certified for single-pilot IFR operations, though operators may choose to utilize a second flight crew member. Pilatus offers the PC-12 in a standard nine-seat airliner form, in a four-seat/freight Combi version, and as a six-seat corporate form of transport. The aircraft, serial number 858, was type certified under the EASA (European Aviation Safety Agency) requirements.

1.6.2 Airframe:

Type	Pilatus PC-12/47	
Serial Number	858	
Manufacturer	Pilatus Aircraft Ltd	
Year of Manufacture	2007	
Total Airframe Hours (At time of Accident)	1 096.2	
Last MPI (Hours & Date)	1 065.2	16 November 2010
Hours since Last MPI	31.0	
C of A (Issue Date)	22 November 2007	
C of A (Expiry Date)	21 November 2011	
C of R (Issue Date) (Present owner)	22 November 2007	
Operating Categories	Standard	

*NOTE:

The aircraft had sustained some damage during a hail storm on 23 October 2009 while it was parked outside at Lanseria Aerodrome. According to the maintenance records, Job Notice No. 1702 that was opened on 28 October 2009, both aileron and elevator assemblies were replaced by new assemblies following the assessment of the damage. An aircraft airframe logbook entry on page 105 reflects that these control surfaces were indeed replaced. The work was carried out by a maintenance organisation which had been approved by the CAA.

The last known defect on the aircraft prior to the accident flight was a flap-related event. On 23 December 2010 the aircraft was scheduled to return to Lanseria aerodrome with passengers from Cape St. Francis, but after start-up the pilot was unable to select 15° of flaps, which was required for takeoff. The pilot then attempted to reset the flaps onboard the aircraft following a discussion via cell phone with a maintenance engineer, but was unsuccessful in doing so. The passengers were left behind and a flapless takeoff was performed and the aircraft was ferried back to FALA, where a flapless landing followed. On 4 January 2011 the aircraft was ferried from FALA to Rand aerodrome (FAGM) where an aircraft maintenance organisation (AMO) attended to the problem by resetting the flap computer (re-zeroed) by making use of a laptop. The maintenance intervention rectified the defect and the aircraft was flown back to FALA on the same day. It should be noted that this defect was not entered in the aircraft flight folio as called for in Part 91.03.5 of the CARs, but came to the attention of the investigating team during an interview with an individual. The interview was then followed up with the maintenance organisation that had rectified the defect. No documented evidence in the form of a logbook entry was made by the person(s) who had carried out such maintenance, which did not meet the requirements as stipulated in Part 43.03.1 (Maintenance records) of the CARs.

A comprehensive overview of the aircraft flight folio was conducted after the aircraft arrived in South Africa in December 2007, as a copy of each and every flight folio entry was on record, with the last few entries still in the flight folio, which was recovered from the sea. It was noted that very few defects were entered into the aircraft flight folio's section 'Description of Defect'. The process of how defects on the aircraft were reported to the AMO was discussed during an interview with members of the AMO. It was noted that the method used to report defects had shifted from the documented format (hard copy entry in the aircraft flight folio) to a more electronic format. It was noted that most of the defects that were reported took place either via e-mail or SMS (short message service) utilizing a cell phone or a laptop. This led to a lack of historical maintenance-related information being available on this aircraft.

1.6.3 Engine:

Type	Pratt & Whitney PT6-67B
Serial Number	PCE-PR0747
Hours since New	1 096.2
Cycles since New	912
Hours since Overhaul	T.B.O. not yet reached (3 600 hours)

1.6.4 Propeller:

Type	Hartzell HC-E4A-3D
Serial Number	KX 522
Hours since New	1 096.2
Hours since Overhaul	T.B.O. not yet reached

1.6.5 Weight and Balance:

The investigating team was unable to determine a detailed weight and balance of the aircraft at the time of the accident. The aircraft was refuelled to capacity on the day prior to the flight at Lanseria aerodrome (FALA) where 1 215 litres (972 kg) of Jet A1 was uplifted. Taking the total flight time into account (3.2 hours), from the time when the aircraft departed from FALA until the accident, it could be determined that approximately 975 litres (780 kg) of fuel had been used, which include the two landings and takeoffs. The fuel consumption was based on a consumption rate of approximately 400 pounds per hour (228 litres / hour), which was obtained following consultation with the aircraft manufacturer. The respective weights of the occupants and luggage could not be determined with certainty following impact with the sea.

1.7 Meteorological Information:

1.7.1 An official weather report was obtained from the South African Weather Services (SAWS) for the Plettenberg Bay area for 8 February 2011.

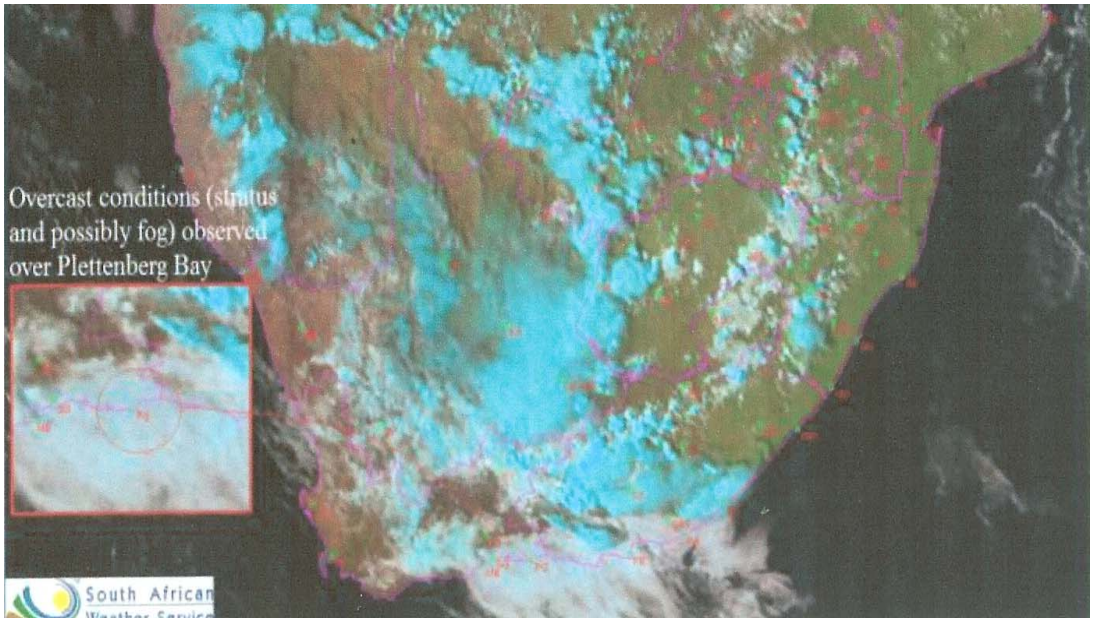
Surface Analysis (1200Z 08 February 2011)

A surface trough over the interior extended to the south-east coast into a coastal low which was propagating eastwards. A high pressure system south-west of the

country pushed in low clouds along the south coast behind the coastal low. Moderate south-westerly to southerly winds were observed and were pushing moist maritime air in with low stratiform clouds.

Satellite Images (1400-1500Z 08 February 2011)

The satellite image (below) reflects overcast conditions along the south coast extending to the adjacent interior, low cloud demarcating the adjacent mountains also indicative of the presence of low stratiform clouds and possible thick fog with drizzle.



A satellite image of the country that was taken at 1430Z on 8 February 2011.

Recorded Weather about the time of the aircraft accident (1400-1500Z METAR)

George was the closest weather station to Plettenberg Bay and provided weather records which were representative of the Garden Route. The official meteorological aerodrome report (METAR) closest to the time of the accident on this day was the one valid for 1430Z and showed reduced visibility in fog and light drizzle.
The Meteorological Aerodrome Report (METAR) for George was as follows:

Date: 8 February 2011 – Time: 1430Z

FAGG 081430Z 20004KT 170V230 4000 -DZ BR BKN002 20/20 Q1015=

FAGG - ICAO location indicator for George Aerodrome
081430Z - Date and Time of issue (UTC)

200°	-	Wind Direction (from True North): in degrees
04kt	-	Wind strength (knots)
4000m	-	Visibility – 4 km
DZ BR	-	Light drizzle and mist
BKN002	-	broken cloud (5 - 7 eights) at 200 feet AGL
20°C	-	Dry bulb Temperature
20°C	-	Dew-point Temperature
1015hPa	-	Pressure: (QNH in hPa)

According to members of the first search and rescue teams that were activated to search for the missing aircraft, dense fog prevailed in the area with forward visibility limited at times to only 5 m. However, these conditions improved at daybreak, which allowed for an official sea search to commence.

According to a member of Cape Nature, which manages the Robberg Nature Reserve, 5 mm of rain was measured at the reserve over a 24-hour period on the day of the accident (8 February 2011). This measurement was taken at the office located at the entry gate to the reserve.

According to the South African Weather Services (SAWS) their automatic weather station (which is used for synoptic and climatological data purposes only) which was located at the Plettenberg Bay aerodrome, measured 4 mm of rain for the day. According to the rainfall chart for the 24-hour period on the day of the accident it was raining at the aerodrome at the time when the aircraft ZS-GAA was expected to land there. This observation was confirmed in a statement by a person who was at the aerodrome at approximately 1430Z to collect some of the passengers.

1.8 Aids to Navigation:

1.8.1 The aircraft was equipped with the following navigational aids:

(i) Very High Frequency Omni-directional Radio Range (VOR)
(ii) Automatic Direction Finding (ADF)
(iii) Instrument Landing System (ILS)
(iv) Distant Measuring Equipment (DME)
(v) Transponder
(vi) Global Positioning Systems (GPS) (Garmin GNS 430, and GNS 530).

1.8.2 The aerodrome navigational aids at FAPG consisted of a single non-directional beacon (NDB) with reference Pappa Yanky (PY), active frequency 227.5 KHz. According to the crew of the Cessna Citation that had landed at FAPG at approximately 1210Z on 8 February 2011, the NDB was fully functional/serviceable at the time, as they flew the cloudbreak procedure for runway 30 twice.

1.9 Communications:

1.9.1 The aircraft was in radio contact with Cape Town Area East on the VHF frequency 124.7 MHz prior to its disappearance from radar.

1.9.2 No record could be found that the aircraft broadcasted any communication on the common traffic advisory frequency for the Plettenberg Bay area on the VHF frequency 124.8 MHz during the approach for FAPG.

1.9.3 No distress call was received by any station from the accident aircraft at any stage of the flight.

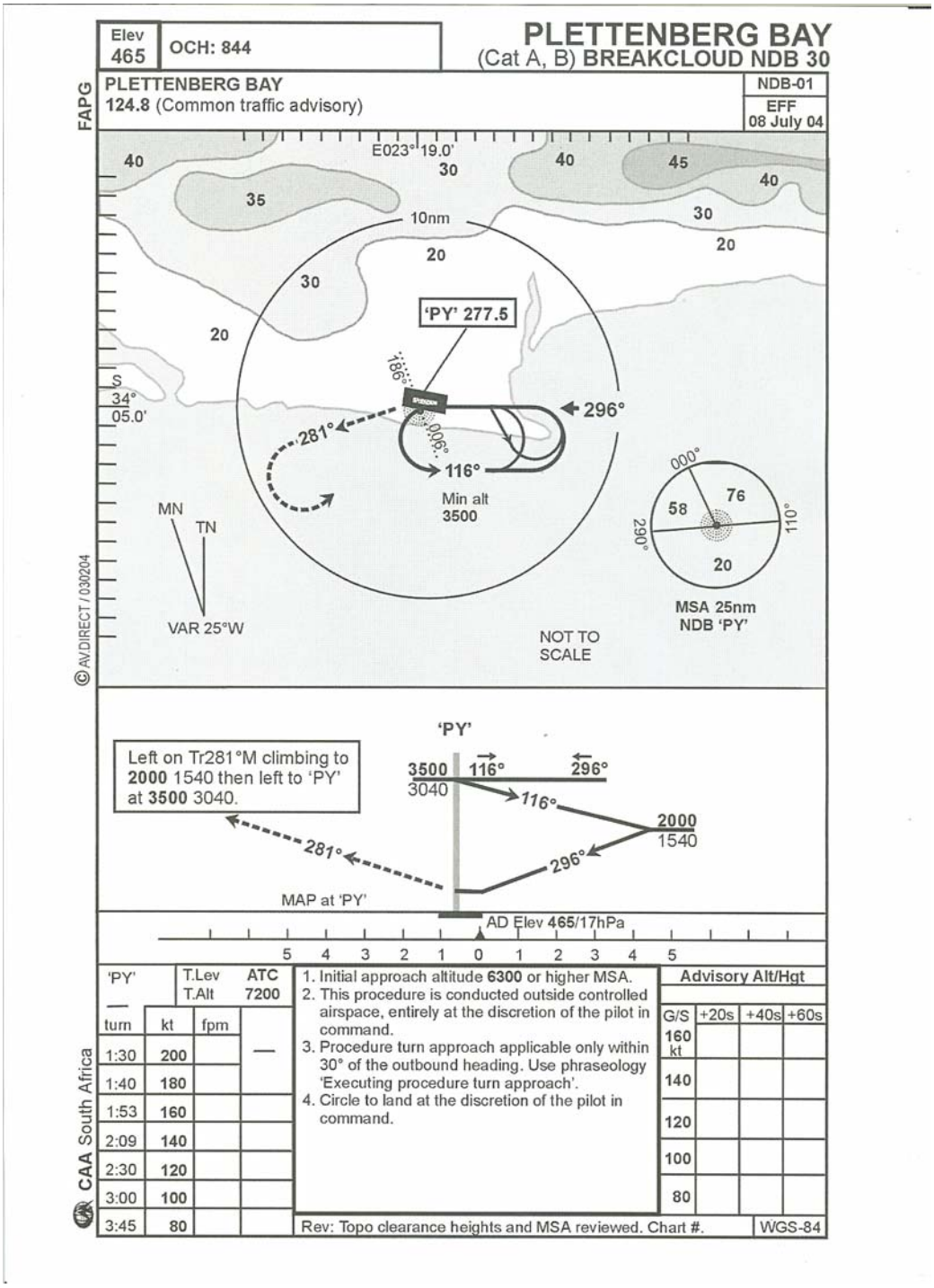
1.9.4 The aircraft was equipped with an emergency locator transmitter (ELT); however, no distress signal was picked up by the designated service provider that might have emanated from the device.

1.10 Aerodrome Information:

1.10.1 The aircraft was expected to land at Plettenberg Bay Aerodrome (FAPG) at approximately 1430Z, but never arrived at the aerodrome. It was later determined that the aircraft had crashed into the sea approximately 2.9 nm south-east of the aerodrome.

Aerodrome Location	2 nm WSW of the town of Plettenberg Bay	
Aerodrome Co-ordinates	South 34°05.0’ East 023°19.0’	
Aerodrome Elevation	465 feet above mean sea level (AMSL)	
Runway Designations	12/30	
Runway Dimensions	1 220 x 20 m	
Runway Used	Not applicable	
Runway Surface	Asphalt	
Approach Facilities	Non-directional beacon (NDB)	
Aerodrome Status	Licensed	

Plettenberg Bay Aerodrome was in possession of a valid aerodrome licence No. 234 that was renewed by the regulating authority on 31 January 2011, with the period of validity indicated on the aerodrome licence certificate as '1 February 2011 to 31 January 2012'. An approved cloud-break procedure NDB for Runway 30 was published on the website of the regulating authority and was also available in the aeronautical information publication (AIP). See the next page for a copy of such a procedure.



1.11 Flight Recorders:

1.11.1 The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required by regulation to be fitted to this type of aircraft.

1.11.2 The aircraft was equipped with an Engine Indication System (EIS), which contained a non-volatile memory (NVM) in the form of a memory card. The memory card was normally used to download Engine Condition & Trend Monitoring (ECTM), which records engine trend data, but also engine exceedance data, if applicable. The EIS display was recovered from the sea after several days, and after recovery was immediately rinsed in fresh water.

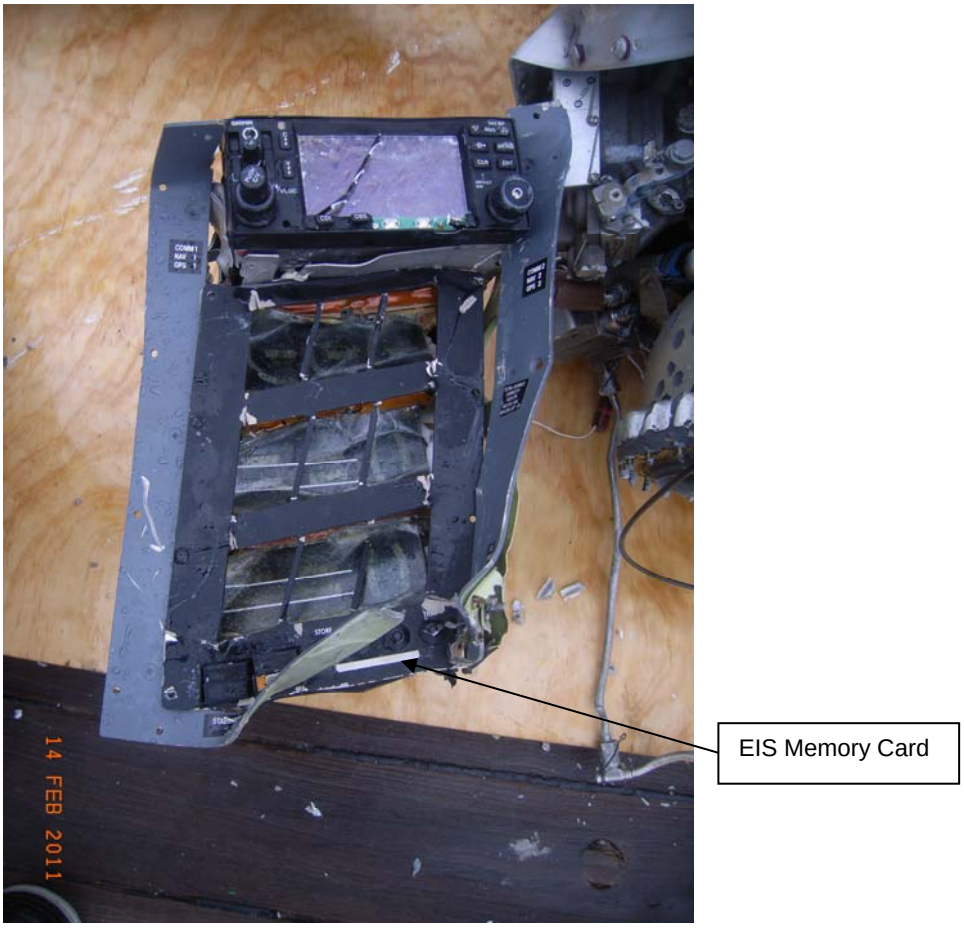


Figure 1. EIS Display

The memory card primarily records engine trend data, but also records engine exceedance data, if applicable. Downloading of the EIS data requires special software. The memory card was transported to Switzerland where it was downloaded on 22 February 2011 at Pilatus Aircraft Ltd under the supervision of the Accredited Representative (A/R) from the Swiss Bureau d'enquêtes sur les accidents d'aviation.

Figure 2. EIS Memory Card

Figure 3. Card Reader

Conclusion

"The EIS memory card most likely sustained internal damage to such an extent that normal data download using the normal tooling was not possible. The reason for this damage was most likely the penetration of salt water into the card itself".

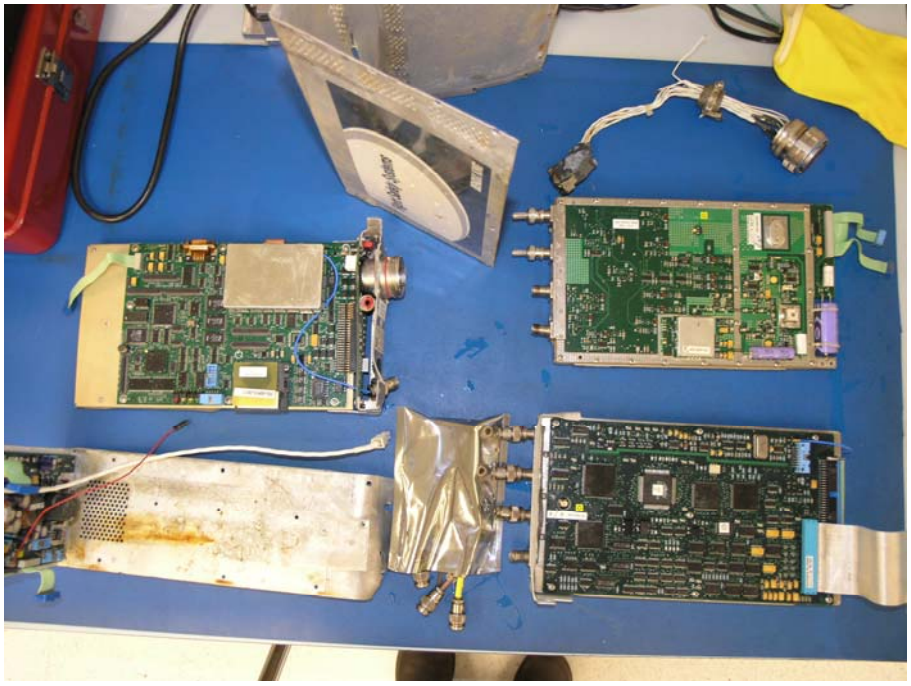
The actual vendor/manufacturer of the memory card was contacted following the download attempt of the memory card referred to above. They indicated that the memory card was not designed nor manufactured as a waterproof unit and by being exposed to the sea water for several days, the flash chip inside most probably deteriorated/broke, with the result that the downloading/retrieval of data was not possible.

1.11.3 Enhanced Ground Proximity Warning System (EGPWS) Examination:

A Honeywell KMH 820 Multi-Hazard Awareness System computer Part No. 066-01175-2101, Serial No. KMH820-A2992, containing EGWPS module Part No. 965-0702-001, Serial No. 03585 was recovered from the sea. The unit was properly rinsed with fresh water after recovery and was placed in a container filled with fresh water. After the unit was offloaded from the Navy vessel it was placed in a sealed container filled with fresh water and was shipped to Honeywell in the United States of America (U.S.A.) in order to establish if any data could possibly be retrieved from the unit.

In accordance with ICAO Anne 13, Honeywell was requested by the South African Civil Aviation Authority (SACAA) via the accredited representative of the National Transportation Safety Board (NTSB) with oversight provided by the US Federal Aviation Association (FAA), to assist in the investigation.

A view of the sealed container that was used for transporting the unit to the U.S.A.



A view of the unit after it was dismantled and cleaned at the Honeywell laboratory.

The dismantled unit being prepared for the drying-out phase at the Honeywell laboratory.

The unit KMH820 was removed from the shipping container on 30 March 2011, whereafter the cleaning and the drying-out process started. The data retrieval process started on 12 April 2011.

Analysis of Fault Data

"Based on the analysis of the EGPWS flight history data the following findings are presented:

This EGPWS module had accumulated 1302 hours of operation since it was originally manufactured in 2007, of which 1078 hours were in flight. This represents 900 flight legs (from takeoff to the next takeoff). The remaining 224 operating hours were on the ground.

Of the 900 flight legs in the flight history record, at least 180 had EGPWS INOP conditions for part or all of the flight legs. The fault history does not record the length of time a unit is faulted for a particular fault – only that it occurred. The INOP faults that were recorded were due to internal EGPWS computer failures for Terrain Database or Application Database (executable code). The EGPWS was INOP for 37 of the first 100 flight legs, 23 of the last 100 flight legs, and 120 of the 700 intermediate flight legs according to the flight history record. Additionally, there is no evidence of EGPWS "Self Test" being performed in the last 10 flight legs when the data was viewed on the test rig computer screen. However, the data containing

the self test history was not captured to a log file during the investigation.

The unit did operate on many flight legs as there is flight history data that indicates that terrain alerts were provided to the crew on those flights.

In the event of a malfunction, the unit is designed to provide a signal to activate the cockpit TERR INOP annunciator. According to the Terrain Function (EGPWS) Pilot's Guide Addendum, the KMD 850 multi-function display (MFD) will also provide inoperative terrain indicators including:

- *"Terrain Inactive" in the Available Functions Legend of the display.*
- *Terrain Awareness State on the Terrain Display Page indicating TERR FAIL when terrain id INOP due to a fault.*

The EGPWS module installed on ZS-GAA was inoperative (INOP) at the time of the accident due to a failure of the internal Terrain Database. Honeywell has not determined any probable cause for the internal failures as the unit had been submerged in salt water and was mechanically damaged during the accident."

An official report was compiled on the findings and observations that were made during the examination and analysis of this unit. The official report will form part of the final accident report.

1.11.4 Another unit that was recovered from the sea that could possibly have stored flight data was the Garmin GNS 430. Correspondence with the manufacturer of the unit revealed that the damage and the salt water ingress would have prevented a power up of the unit. Therefore it was not possible to determine the last loaded flight plan from the unit.

1.12 Wreckage and Impact Information:

1.12.1 Due to the fact that the aircraft crashed into the sea, no official wreckage diagram could be drawn up, as it was essential to recover as much of the debris in the shortest possible timeframe. No underwater video or photos were taken of the wreckage. This decision was supported by the fact that the wreckage was at a substantial depth, which limited diving time and made the recovery of wreckage parts a priority. The last known heading that the aircraft was tracking before it disappeared from radar was approximately 006°M (341°T + variation of 25°).

Figure 1. Estimated impact location (viewed from land).

Figure 2. A view from the sea of the estimated impact location.

1.12.2 This image (see figure 3 below) was made available by the South African Navy, and indicates the images that were picked up by the side scan sonar that was being utilized in order to locate the wreckage. The image provides reflections and no actual components/parts could be allocated to a certain object as reflected, but it does provide the reader with some insight into the wreckage field.

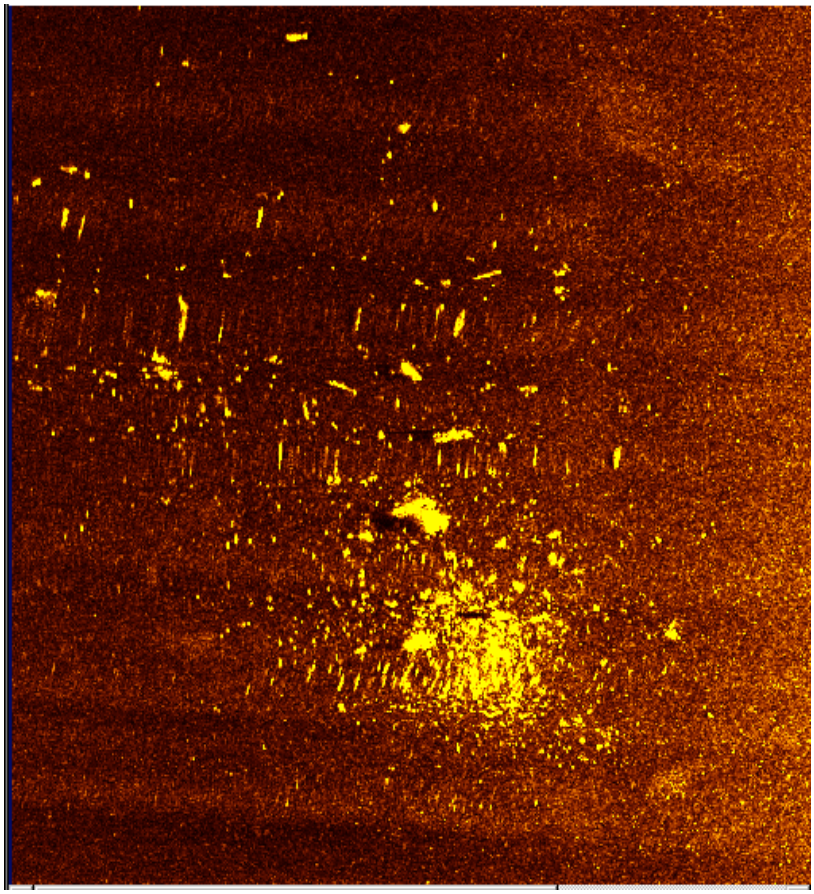


Figure 3. Side scan sonar image of debris field under the water, courtesy of SA Navy.

1.12.3 Forward, Centre and Aft Sections of the Aircraft

The propeller, with two of the four blades still attached to the hub assembly and the reduction gearbox of the engine were recovered, and so was the engine.

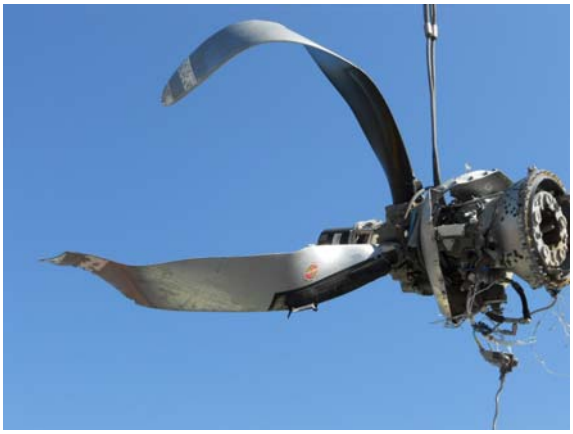


Figure 4. A view of the propeller.

Figure 5. A view of the engine

Several parts of the fuselage section were recovered, however, except for a few parts, the entire section from frame 10 (firewall) to approximately frame 27 (in front of the cargo door) is still missing (see figure 6 for reference to the frame numbers). This includes the right wing, from which only the weather radar dome/cover and the

flap assembly were located.

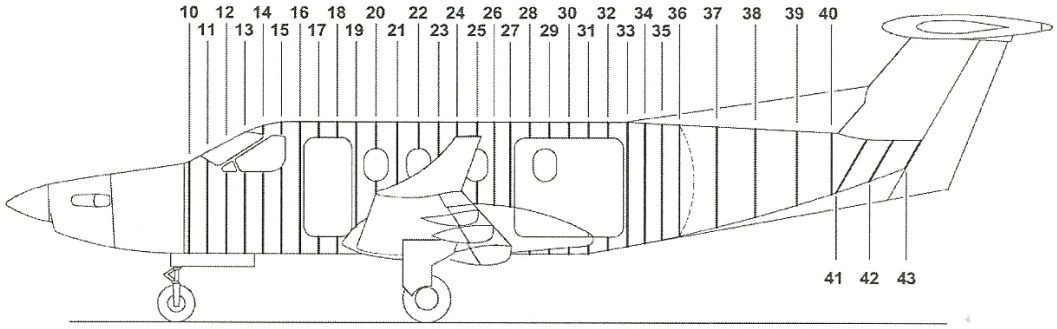


Figure 6. Fuselage Structure Identification

A section of the left wing was recovered (see figure 7). The inner part of the wing up to rib 5 is missing (refer to Figure 8). The outer part of the wing is fractured in the area of rib 16. Except for the wing tip, none of the pieces of this section was found. The inner leading edge is missing and the tank area had burst open. The rear spar of the wing was fractured at the landing gear attachment. Both wing fuselage/wing attachments are missing. No pieces of the left main landing gear were found.

Figure 7: A view of the left wing that was recovered with a section of the flap attached.

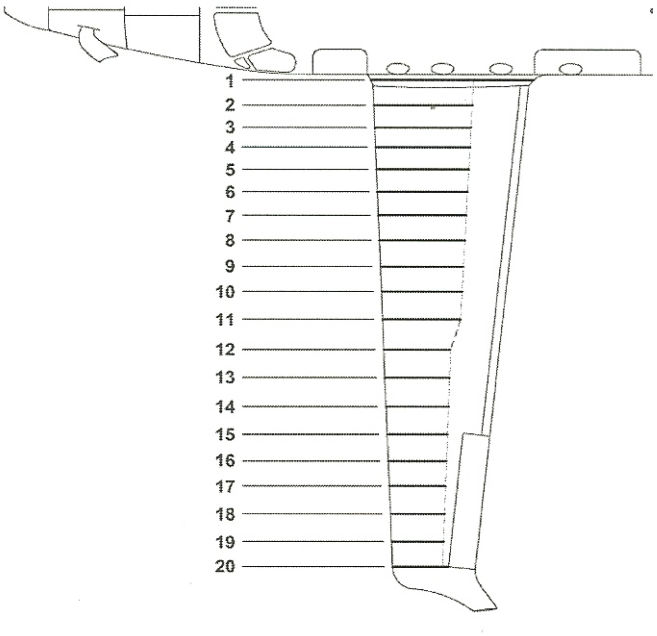


Figure 8. Left wing sections.

The outer flap screw actuator of the left wing was still attached to the rear spar. The actuator was found in the 'flap up' position.

Except for one bellcrank (see Figure 9) (left-hand outer), no other parts of the aileron system, including the surfaces itself, were found. The aileron trim actuator (located on the left side) was not recovered either, therefore aileron control continuity could not be established.

Figure 9. The left-hand outer aileron bell crank.

As none of the three landing gear actuators or any other landing gear component was found, it was not possible to determine the landing gear configuration at the

time of impact with 100% certainty. The left-hand side landing gear attachment point at the rear wing spar did not show any signs of torsion (see Figure 10).

Figure 10: Left-hand landing gear attachment point at the wing main spar.

Fuselage Structure (Cargo door {station 27} and aft)

The cargo door area and associated structure were recovered from the sea. The cargo door was found still attached to the hinge on the top fuselage. The 3 hooks were free to rotate, as the locking mechanism reflected damage to the individual units. One shoot bolt was found out and jammed, which was an indication that the door was closed and locked at the time of impact.

Figure 11. Cargo door with shoot bolt.

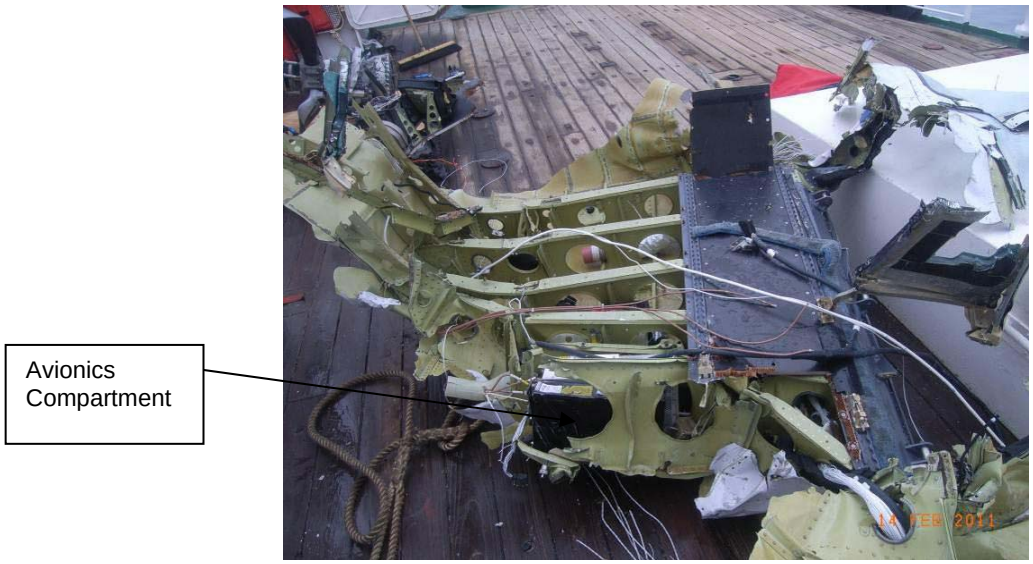


Figure 12. Bottom part of the cargo door, fuselage section.

Figure 13. Top part of cargo area, fuselage section.

The forward section of the empennage, the vertical stabiliser including the rudder as well as the horizontal stabiliser were recovered from the sea. The rudder and flight control cables were still attached to the horizontal stabiliser with minor damage observed. The cables were found to have fractured under tension/overload. The horizontal stabiliser had separated at its attachment to the vertical stabiliser with substantial damage observed on the right-hand surface, which could be associated with impact. The elevator was still attached to the horizontal stabilizer and the hinges were damaged by impact forces. Approximately half of the left-hand surface was missing; this was associated with impact damage. The push-pull rod from the bell-crank to the elevator was found to be fractured and bent. The control cables were still attached to the bell-crank. The cables were found to have fractured in overload mode. Up to this point, continuity was established. As no other pieces of

the elevator control system were found, the continuity of the forward part of the system could not be established.

Figure 14. Forward section of the empennage.

Figure 15. The vertical stabiliser, including the rudder.

Figure 16. Horizontal stabiliser

1.13 Medical and Pathological Information:

1.13.1 The post-mortem examinations of seven (7) of the occupants who perished in this accident were conducted in George on 12 February 2011 by a forensic pathologist.

1.13.2 Two of the occupants who had perished in the accident were identified by DNA (deoxyribonucleic acid) profiling after several tissue samples had been evaluated by a forensic laboratory in Cape Town.

1.13.3 The cause of death of all nine (9) occupants was concluded to be as a result of multiple injuries sustained during the impact sequence.

1.13.4 Toxicological tests were performed only on the PIC as it was possible to attain eye fluid during the post-mortem examination. The test result indicated that the concentration of alcohol in the blood specimen was 0.00 grams per 100 millilitres. No sodium fluoride analysis was possible as the specimen size was too small.

1.13.5 No toxicological tests were performed on the co-pilot as no bodily fluid could be obtained in order to perform such tests.

1.14 Fire:

1.14.1 There was no pre- or post-impact fire.

1.15 Survival Aspects:

1.15.1 This was not considered a survivable accident due to the high kinetic energy associated with the impact sequence that was well above that of human tolerance.

1.16 Tests and Research:

1.16.1 The Engine

The engine, a Pratt & Whitney PT6A-67B, Serial No. PCE-PR0747, was recovered from the sea and was transported on a South African Navy vessel to Port Elizabeth where it was offloaded and transported to an approved engine maintenance facility at Lanseria Aerodrome. The engine was continuously rinsed with fresh water once it was recovered from the sea and while being transported on the vessel to port.

The Accident and Incident Investigation Division (AIID) requested assistance with the teardown of the engine from Pratt and Whitney Canada (P&WC) via the Transport Safety Board (TSB) of Canada. An Investigator and Field Service Representative of P&WC were made available and the engine investigation was performed over the period 22 - 23 February 2011.

The engine displayed severe impact and salt water immersion damage, including

complete structural separation of the reduction gearbox forward housing. The propeller assembly remained attached to the propeller shaft. Portions of the airframe shrouding and pneumatic bleed system remained attached.

"A brief summary of observations, engine displayed deformation to the compressor 1st stage blades and contact signatures to the compressor axial stages, compressor impeller and shroud, compressor turbine, 1st stage power turbine vane ring and shroud, 1st stage power turbine, 2nd stage power turbine vane ring shroud, 2nd stage power turbine, and torsional fracture of the reduction gearbox propeller shaft coupling webs characteristic of the engine producing power at impact, likely in the middle to high power range. There were no indications of any pre-impact mechanical anomalies or dysfunction to any of the components observed."

Photo No. 1
General view of the engine (right-hand side).

Compressor Section

Compressor Discs and Blades: The 1st stage blade airfoils were deformed randomly forward and away from the direction of rotation. The blade airfoil leading edges displayed nicks and deformation. The 2nd stage blade airfoils displayed slight nicks and deformation. The 3rd and 4th stages were intact. Please refer to photos No. 2 to 5.

Photo No. 2
Compressor 1st stage disc.

Photo No. 3
Compressor 1st, 2nd, 3rd, and 4th stage discs.

Photo No. 4
Centrifugal impeller detail.

Photo No. 5
Centrifugal impeller shroud detail.

Combustion Chamber Liner: Displayed no indications of operational distress. The outer liner flame pattern indications appeared normal. Please refer to photo No. 6.

Photo No. 6
Combustion chamber liner and compressor turbine, in-situ.

Turbine Section

Compressor Turbine: The blade airfoils displayed no indications of distress. The upstream side blade platforms displayed circumferential rubbing due to contact with the compressor turbine vane ring inner drum. The downstream side blade platforms and disc outer rim were circumferentially machined due to contact with the 1st stage power turbine vane ring. The hub face was circumferentially rubbed due to contact with the interstage baffle. Please refer to photos No. 7 to 9.

Photo No. 7
Compressor turbine, in-situ.

Photo No. 8
Compressor turbine, downstream side.

Photo No. 9
Compressor turbine downstream side detail.

1st Stage Power Turbine: The upstream side blade roots and the blade tip shrouds displayed circumferential rubbing and machining due to contact with the 1st stage power turbine vane ring. The downstream disc outer rim and blade outer spans were circumferentially rubbed, and the outer spans deformed and fractured, due to contact with the 2nd stage power turbine vane ring. The blade tips were circumferentially rubbed due to contact with the shroud. Please refer to photos No. 10 and 11.

Photo No. 10
1st stage power turbine, upstream side.

Photo No. 11
1st stage power turbine upstream side detail.

2nd Stage Power Turbine Vane Ring: The vane airfoil leading edges and vane ring inner drum were circumferentially rubbed and machined from the approximate 6:00 to 10:30 positions due to contact with the 1st stage power turbine. The vane ring downstream side displayed heavy circumferential rubbing and machining, with the heaviest concentration from the approximate 1:00 to 3:00 positions due to contact with the 2nd stage power turbine. The interstage abradable air seal displayed heavy

circumferential rubbing, with frictional heat discoloration, due to contact with the air seal rotor knife edges. Please refer to photos No. 12 and 13.

2nd Stage Power Turbine Shroud: Displayed heavy circumferential rubbing due to contact with the 2nd stage power turbine blade tips. Please refer to photo No. 14.

Photo No. 12
2nd stage power turbine vane ring, upstream side.

Photo No. 13
Interstage abradable airseal detail, approximate 9:00 position.

Photo No. 14
2nd stage power turbine vane ring downstream side and shroud, approximate 2:00 position

2nd Stage Power Turbine: The blade airfoils were circumferentially fractured at heights varying from the root to approximately 1/4 span due to contact with the duct, shroud, and 2nd stage power turbine vane ring. Fractured blade material remained in the exhaust duct. The recovered blade tips displayed circumferential rubbing. The upstream side blade platforms displayed circumferential machining due to contact with the vane ring. The downstream side blade platforms and disc face displayed circumferential rubbing due to contact with the power turbine shaft housing and exhaust duct inner shroud. Under unaided visual and macroscopic inspection all of the blade fractures displayed course dendritic features and displayed no indications of fatigue or other progressive fracture mechanism. Please refer to photos No. 15 and 16.

Photo No. 15
2nd stage power turbine and power turbine shaft, upstream side.

Photo No. 16
2nd stage power turbine downstream side, detail

Photo No. 17
Recovered 2nd stage power turbine blades.

Power Turbine Shaft and Shaft Housing: The power turbine shaft was fractured from the reduction gearbox coupling. The shaft face displayed severe circumferential rubbing and deformation. The power turbine shaft housing was not recovered. The exhaust duct inner shroud displayed circumferential scoring due to contact with the 2nd stage power turbine. Please refer to photo No. 18.

Photo No. 18
Power turbine shaft forward section compared to exemplar shaft.

Reduction Gearbox

The 2nd stage gearing was observed in-situ in the reduction gearbox forward housing. The gearing displayed severe corrosion damage. The 2nd stage planet gear carrier to propeller shaft spline mounting webs was fractured in torsion. The fractured webs displayed counter-clockwise torsional deformation. The reduction gearbox rear housing and 1st stage gearing were not recovered. Please refer to photos No. 19 and 20.

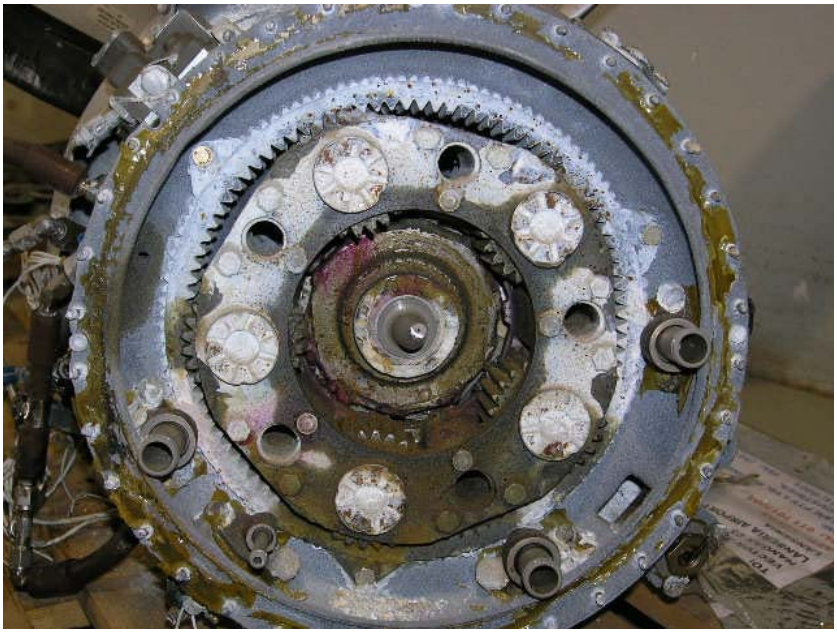


Photo No. 19
Reduction gearbox 2nd stage gearing.

Photo No. 20
2nd stage planet gear carrier propeller shaft coupling.

Accessory Gearbox

Severe corrosion damage precluded disassembly of the accessory gearbox. The reduction gearbox coupling was intact.

Evaluation of Controls and Accessories

Salt water immersion damage precluded evaluation of the controls and accessories. The fuel control unit was separated from the high pressure fuel pump for inspection of the governor drive shaft. The shaft was intact and could be rotated by hand. Please refer to photos No. 21 and 22.

Photo No. 21
Fuel control unit and high pressure pump, right-hand view

Photo No. 22
Fuel control unit governor drive shaft.

1.16.2 Left Elevator Examination:

The horizontal tail plane of the aircraft was recovered from the sea. It was noted that the right horizontal stabilizer had suffered some impact damage on the leading edge, however the right elevator assembly remained attached to the stabilizer surface. It was, however, noted that the outer section of the left elevator had failed and was unaccounted for. The horizontal tail plane was inspected by a metallurgist and the left elevator assembly was removed in order to establish the failure of the flight control surface.

Discussion and Conclusion

"The possibility of failure due to in-flight flutter of the elevator was contemplated. However, the results from this investigation point towards impact rather than flutter-induced failure during operation, based on the following observations:

(i) In the majority of cases where flutter resulted in the failure of control surfaces during operation, the entirety of the surface will show comparable damages. In this case the right-hand section of the elevator failed to reveal the same.

(ii) The top and bottom elevator movement stops revealed no clear evidence of excessive impact wear or damages.

(iii) The elevator counter weight proved to be in relative good condition with no clear indications of exposed train typical to flutter inputs.

(iv) The connecting bracket fracture surface points towards failure on impact and not during operation, which may have resulted in loss of elevator control and/or flutter thereof.

The full investigation report on the failure mode of the left elevator will be included in the final accident report.

1.16.3 Analogue Flight Instruments Examination:

The aircraft was equipped with an electronic flight instrument system (EFIS) on the left instrument pedestal and analogue flight instruments on the right pedestal. It also had installed an analogue standby artificial horizon (AH) on the left pedestal. Three analogue instruments were recovered from the sea and were submitted for

further examination. The instruments were as follows:

(i) Attitude Indicator, Part No. 504-01110-930, Serial No. 504 011193025230
(ii) Directional Indicator, Part No. 066-3060-01, Serial No. 12080,
(iii) Directional Indicator, Part No. 066-3046-07, Serial No. 96910.

"The investigation results from the Attitude Indicator (Artificial Horizon) point toward a right wing down, approaching inverted aircraft attitude on impact. The pitch attitude could not be determined conclusively from the Attitude Indicator but was assumed to be nose down at an undetermined angle.

Although the visual investigation revealed extensive impact and corrosion damages to both Directional Indicators, the extent of damage proved to be sufficient to arrest the inner gyroscopic parts for impact analysis purposes. However, both Directional Indicators revealed comparable readings of 115° and 105° SE. This could not be confirmed conclusively as the actual direction of impact".

The full investigation report on these three instruments will form part of the final accident report.

1.17 Organisational and Management Information

1.17.1 The flight was conducted under the provisions of Part 91 (Private) of the Civil Aviation Regulations of 1997. The services of a first officer were obtained for this flight, even though the aircraft was certified for single pilot IFR.

The Civil Aviation Regulations, Part 135.02.1 (Composition of flight crew) sub-paragraph 6 and 7 state the following;

"(6) ***For operations under IFR*** *or by night* ***in a small commercial air transport turbo-propeller*** *or turbojet* ***aeroplane,*** *an operator shall ensure* ***that the minimum flight crew is two pilots:*** *Provided that in the case of a turbojet aeroplane, a single-pilot operation is allowed if –*

(a) the aeroplane has been certificated for single-pilot IFR operation; and
(b) the operator has included in the operations manual, referred to in Regulation 135.04.2, a conversion and recurrent training programme for pilots which includes the additional requirements for a single-pilot operation.

(7) The operator shall designate one pilot among the flight crew as pilot-in-command of a small commercial air transport aeroplane and the pilot-in-command may delegate the conduct of the flight to another suitably qualified pilot".

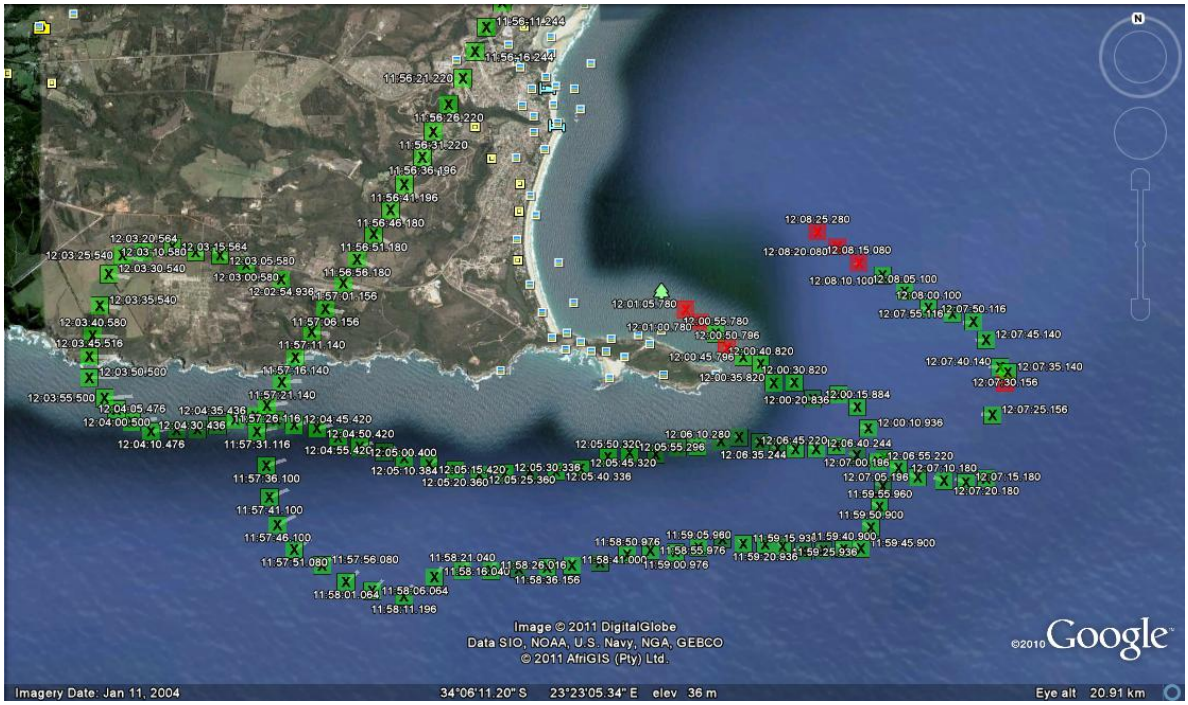
1.17.2 The last maintenance that was carried out on the aircraft was certified by a CAA Approved AMO (Aircraft Maintenance Organisation). The facility was in possession of a valid AMO Approval certificate that was issued on 1 April 2010 and remained valid until 31 March 2011.

1.18 Additional Information:

1.18.1 The Radar Trajectory of a Cessna Citation over the Plettenberg Bay area.

As part of the investigation, the Accident and Incident Investigation Division (AIID) obtained the radar trajectory that was flown by the crew of a Cessna Citation (ZS-PAJ). This aircraft had departed from Lanseria aerodrome (FALA) on a flight to FAPG. The aircraft landed at FAPG at approximately 1210Z approximately 2½ hours before the accident aircraft (ZS-GAA) was expected to land at FAPG. On the Google Earth map below it can be seen that the aircraft (ZS-PAJ) approached FAPG from the north-east, flew over the NDB beacon "PY" at the aerodrome and then turned out left, outbound over the sea and after some distance turned right inbound to intercept the beacon. On final approach the crew performed a missed approach as they encountered low cloud and rain, which reduced their forward visibility considerably and it was decided by the PIC to climb out and enter the pattern for a second landing attempt. On the second leg they extended their outbound leg over the sea and after some distance turned right to intercept the beacon followed by an uneventful landing on runway 30.

On both the inbound legs (approach phase) radar coverage with the aircraft was lost, which could be attributed to the aircraft being on the descent to land (relatively low) as well as terrain (mountainous area) interference.



The radar pattern reflects the trajectory that was flown by the aircraft ZS-PAJ that landed at FAPG at ±1210Z.

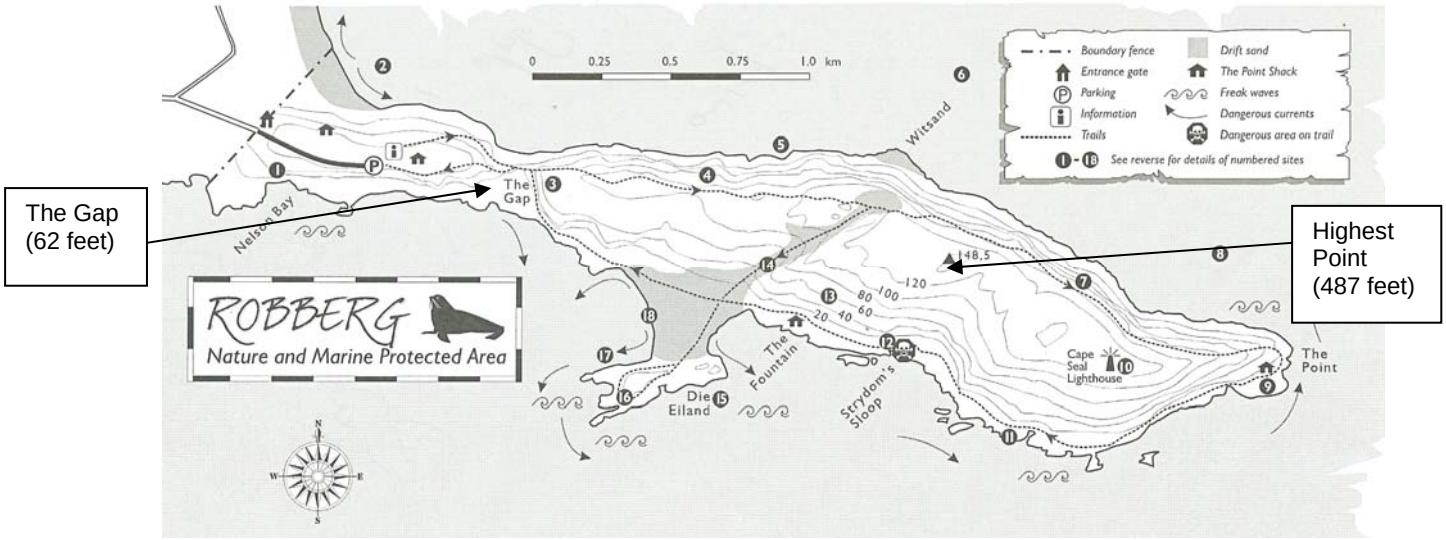
1.18.2 The Radar Trajectory of ZS-GAA over the Plettenberg Bay area.

The radar trajectory/track that was flown by the crew of the accident aircraft was obtained and assessed. From the data it was possible to determine the track that was flown by the aircraft ZS-GAA after it departed from Queenstown until it disappeared from radar coverage over the sea near the Robberg Nature Reserve.

On the Google Earth map below it can be seen that the aircraft had approached the Plettenberg Bay area from the north-east. The aircraft continued with the descent while flying in a south-westerly direction and went over the sea between Keurboomstrand and Nature's Valley. The radar track indicates the first leg of the descent over the sea to be a distance of approximately 7.3 nm. Radar coverage with the aircraft was then lost for a distance of approximately 2.2 nm. For the last 4 nm prior to the aircraft's disappearance from radar, another 10 radar positions were recorded of which two were '*red dots'*, which indicate that the radar had lost the target but made an official prediction of where it would have been next, which is referred to as *coasting.*

The last height reflected on the straight line approach's last 'green dot' was 1150 feet. Thereafter radar coverage with the aircraft was lost for a period of approximately 1 minute and was then re-established for a period of 1 minute before the aircraft disappeared from radar permanently.

The loss of radar coverage around the Robberg point could be attributed to high ground/mountainous terrain, with the highest point on the Robberg Nature Reserve indicated as 487 feet (148.5 m) above mean sea level (AMSL). The height of the terrain in the area of "The Gap", which was the lowest point in the reserve (apart from the sandy beach area point 18 on map below) is 62 feet (19 m) AMSL, according to information obtained from Cape Nature. Both locations are pointed out on the map of the Robberg Nature Reserve below.



A map layout of the Robberg Nature Reserve with the "Highest Point" and "The Gap" indicated.

The radar pattern reflects the trajectory that was flown by the aircraft ZS-GAA before disappearing off radar.

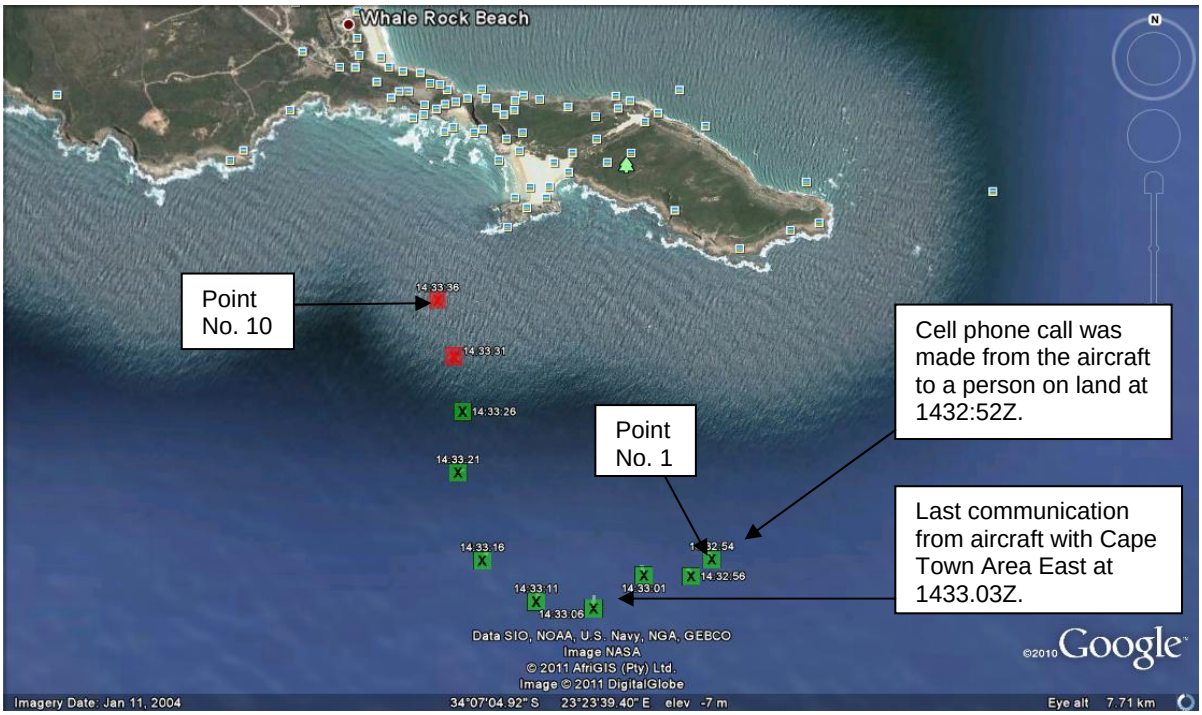
The column on the next page reflects the last 10 positions that were captured prior

to the disappearance of the aircraft from radar. These positions were plotted on Google Earth and are indicated by 8 green square blocks, each with a time stamp and 2 red blocks.

*NOTE:
The speed displayed on the radar that was entered into the column on the next page is referred to as "*Calculated Track Velocity Speed*".

It is of interest to note that the aircraft was on the descent and during the right turn it pitched up from a height of 900 feet AMSL (position 1 out of 10) to a height of 1 375 feet in a period of 12 seconds. This accounts to a rate of climb (ROC) of 39.6 feet per second or 2 375 feet/min. During these few seconds the speed decayed from 168 to 151 knots. The pitch-up event was followed by an immediate pitch-down event with an associated rate of descent (ROD) of approximately 2 400 feet/min (this data was obtained by only utilizing data from the green track radar points). The aircraft continued to descend until it disappeared from radar.

No.	GPS Position	Time (HH:mm:ss)	Speed (kts)	Height (ft) (amsl)
1	South 34° 07'51.23" East 023° 24'12.22"	14:32 54	168	900
2	South 34° 07'.55.55" East 023° 24'06.09"	14:32 56	168	975
3	South 34° 07'55.48" East 023° 23'51.55"	14:33 01	156	1 200
4	South 34° 08'04.01" East 023° 23'36.43"	14:33 06	151	1 375
5	South 34° 08'02.79" East 023°23'18.84"	14:33 11	155	1 350
6	South 34° 07'53.12" East 023° 23'02.84"	14:33 16	157	1 125
7	South 34° 07'31.71" East 023° 22'55.80"	14:33 21	163	850
8	South 34° 07'17.37" East 023° 22'57.51"	14:33 26	163	575
9	South 34° 07'04.36" East 023° 22'55.21"	14:33 31	160	425
10	South 34° 06'51.37" East 023°22'50.12"	14:33 36	160	300



The radar pattern reflects the trajectory of the aircraft (ZS-GAA) indicating the last 10 points/positions.

1.18.3 Civil Aviation Regulations (CARs)

Emergency Locator Transmitter (ELT)

Part 91.04.26

"(1) "No owner or operator of –

(a) an aircraft to be operated on extended flights over water or over areas where search and rescue would be especially difficult;

(b) an aeroplane with a maximum certificated mass exceeding 5 700 kg;

(c) a helicopter with an approved passenger seating configuration of more than 19 seats; or

(d) any South African registered aircraft engaged in an international commercial air transport operation;

shall operate such aircraft unless it is equipped with one or more approved emergency locator transmitters (ELTs)".

(4) The Commissioner shall maintain a register of all aircraft equipped with 406 MHz ELTs, which shall contain the following particulars:

(a) The nationality and registration marks of the aircraft;

(b) Particulars of the manufacturer's designation and serial number of the aircraft;

(c) The full name and contact details of the registered owner of the aircraft;

(d) The make and model number/s of the ELT/s;

(e) The 15-digit Unique Identification Number (UIN) provided by the manufacturer of the ELT, or the aircraft's Mode S transponder code; and

(f) The name/s and contact details of the person/s who know/s the aircraft's itinerary and who may be contacted 24 hours a day.

(5) On the payment of the appropriate fee as prescribed in Part 187, an excerpt of the ELT register shall be furnished by the Commissioner to any person who requests such an excerpt".

It was found that the aircraft was equipped with a Serpe-IESM Kannad 406 MHz ELT, however the unit was not registered on the database as called for in subpart 4 of Part 91.04.26 of the CARs. Nor did any station report any emergency signal being picked up at the time of the accident or subsequent to the accident that could have been associated with the aircraft ZS-GAA.

1.19 Useful or Effective Investigation Techniques:

1.19.1 None.

Report reviewed and amended by the office of the Senior Manager - Accident Investigations for release in October 2011.

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